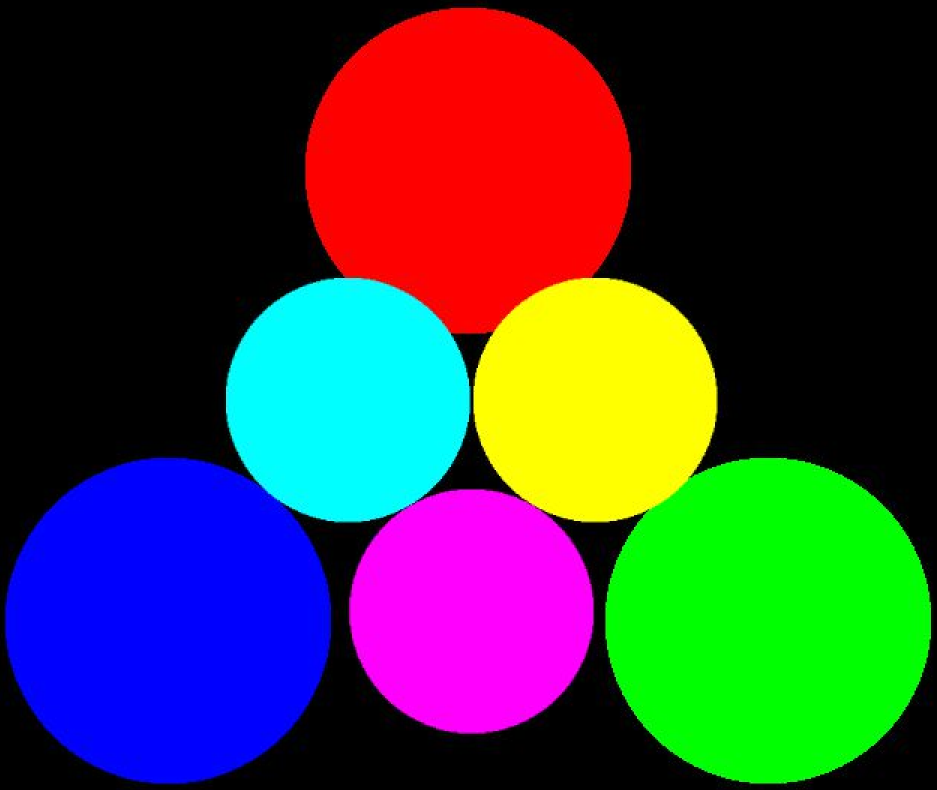


When Red and Green are overlayed onto one another, they form 60 degree Yellow but this is not a true CMY color.

This is a virtual version of the color Yellow created by a RGB spectrum, as yellow on a CMYK base occurs at 57 degree hue angle. The same applies of the Magenta and Cyan that RGB creates.

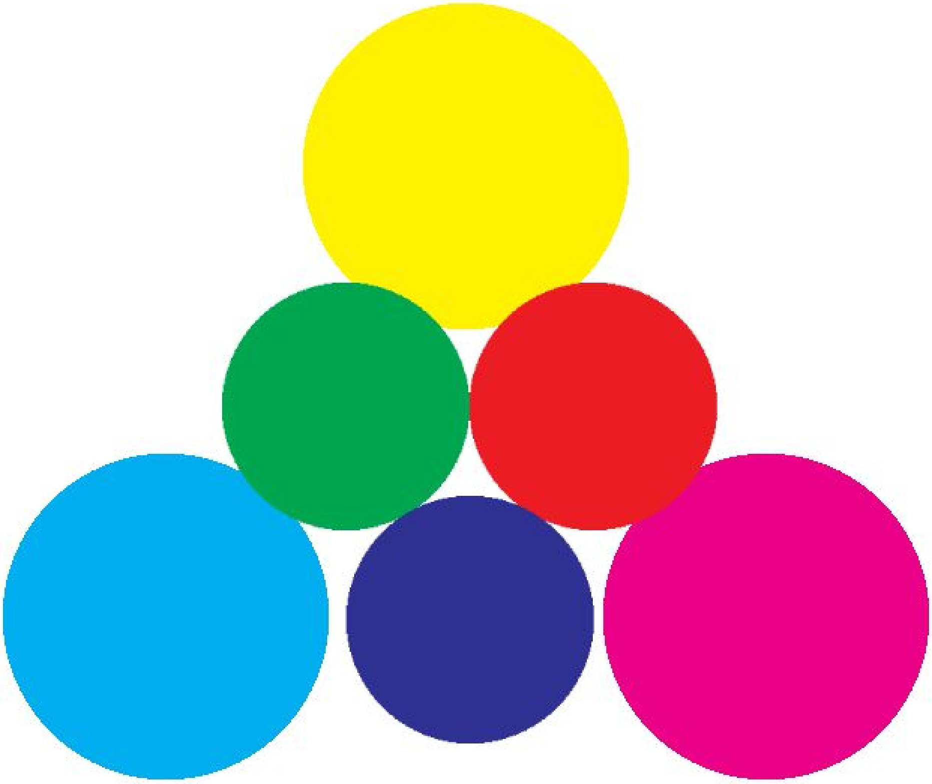
In the additive RGB model, Red and Green combine to create Yellow, which lies at a 60° hue angle. This Yellow is a virtual color because it is produced by the overlap of Red and Green light.

Similarly, Magenta (produced by overlapping Red and Blue) and Cyan (produced by overlapping Green and Blue) are also virtual colors in the RGB model.

The hue angle is a perceptual measurement within a color space like HSL or HSV. Additive (RGB) and subtractive (CMY) models have slightly different spectral responses, which can shift these angles slightly.

RGB uses emitted light directly. The hues are mathematically distributed evenly in the HSL/HSV space, with Cyan, Magenta, and Yellow at 180°, 300°, and 60°, respectively.

CMYK colors arise from the absorption and reflection of light. These physical processes are influenced by the spectral properties of the reflector, in this case Black; which does not align perfectly with their theoretical RGB counterparts.



The hue angles for Red, Green, and Blue within the CMY/CMYK color model differ slightly from their theoretical counterparts in the RGB model. This discrepancy reflects the complex realities of how pigments and light interact in the subtractive color space.

RGB works by generating light energy, building from darkness toward brightness.

CMYK operates by taking light away, building from brightness toward darkness.

RGB thrives in darkness, where light is absent.

CMYK thrives in brightness, drawing on its power to absorb and manipulate light.

The reflective nature of CMYK colors lies at the core of how the subtractive color model operates. CMYK colors interact with light and surfaces in ways fundamentally different from the emitted light of RGB.

Cyan pigment absorbs red light and reflects green and blue. Magenta absorbs green light and reflects red and blue. Yellow absorbs blue light and reflects red and green.

When these physical colors overlap, they absorb more wavelengths, creating different colors through the remaining reflected light.

In the additive RGB model, Cyan, Magenta, and Yellow are not true subtractive colors. They are approximations created by combining different RGB primaries:

Cyan (180°): Equal intensities of Green and Blue light.
Magenta (300°): Equal intensities of Red and Blue light.
Yellow (60°): Equal intensities of Red and Green light.

These RGB combinations mimic CMY colors perceptually but lack the subtractive interaction of real CMY pigments. They are "virtual" because they rely on emitted light rather than pigment-based reflection.

In the subtractive CMY model, Red, Green, and Blue are approximations formed by subtracting one primary wavelength at a time:

Red (358°): Magenta and Yellow overlap, absorbing Blue and leaving Red.
Green (149°): Cyan and Yellow overlap, absorbing Red and leaving Green.
Blue (239°): Cyan and Magenta overlap, absorbing Green and leaving Blue.

These approximations depend on reflected light and the imperfections of pigments, making them distinct from the emitted light of RGB.

When one model tries to replicate the other, it must translate its process:

RGB mimicking CMY: It overlays light to simulate how pigments would reflect it.

CMY mimicking RGB: It subtracts wavelengths to simulate the light-mixing behavior of RGB.

This translation is inherently limited and produces approximations rather than perfect equivalents.

Colors created by RGB are inherently light-based and cannot achieve the tactile, reflective qualities of CMY pigments.

Colors created by CMY are inherently reflective and cannot achieve the brightness or vibrancy of RGB light emissions.

RGB and CMY are complementary but not interchangeable systems. Each creates virtual approximations of the other's colors, but they are never perfect. Understanding their unique behaviors allows us to use each model effectively in its respective domain.

The RGB model begins in darkness (black), where there is an absence of light. All light is added to this emptiness, culminating in pure white light when the hands of Red, Green, and Blue combine at full intensity.

The CMY model begins with light, often a white reflective surface. Darkness is not its starting point, but its creation. By absorbing light selectively, it carves hues out of brightness.

CMY colors created by subtraction of light interact with HSL and HSV in unique ways due to their reflective nature. Here's how HSL/HSV concepts relate to CMY:

Hue:

True CMY colors align with their theoretical subtractive counterparts on the hue wheel but often show slight shifts due to pigment imperfections:

Cyan: ~196° (CMY) vs. 180° (RGB).
Magenta: ~325° (CMY) vs. 300° (RGB).
Yellow: ~57° (CMY) vs. 60° (RGB).

In HSL/HSV, these shifts can be approximated but not perfectly represented unless the system accounts for CMY's subtractive behavior.

Saturation and Color Purity:

Saturation in HSL/HSV measures how vivid a color is, but this is limited when approximating CMY because true CMY colors involve light absorption and reflection rather than emitted light.

CMY colors, especially in print, are influenced by the medium (paper, ink) and the viewing conditions (ambient light). This can result in muted colors that appear less saturated compared to their RGB representations.

Lightness and Reflectivity:

In HSL, lightness is tied to the proportion of lightness and darkness in the perceived color. For CMY, this corresponds to the balance of ink coverage:

A fully saturated Cyan in CMY would correspond to a mid-lightness Cyan in HSL, as the pigment reflects a mix of Green and Blue light.

Increased ink coverage in CMY reduces lightness, darkening the color while retaining its hue.

In HSV, value captures the maximum brightness possible for a given color. CMY's subtractive process inherently limits this brightness compared to RGB's emitted light.

Contrast Between Reflective and Emissive Models:

HSL and HSV cannot fully express the reflective qualities of CMY because they are based on light emission, not light subtraction. The reflective properties of CMY pigments interact with ambient light, creating a dynamic perception that HSL/HSV models cannot replicate.